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# Analysis of Earthquake Data from the Greater Los Angeles Basin and Adjacent Offshore Area, Southern California

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Element I & III

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## ABSTRACT

We synthesize and interpret local earthquake data recorded by the Caltech/USGS Southern California Seismographic Network (SCSN/CISN) in southern California. The goal is to use the existing regional seismic network data to: (1) refine the regional tectonic framework; (2) investigate the nature and configuration of active surficial and concealed faults; (3) determine spatial and temporal characteristics of regional seismicity; (4) determine the 3D seismic properties of the crust; and (5) delineate potential seismic source zones. Because of the large volume of data and tectonic and geologic complexity of the area, this project is a multi-year effort and has been divided into several tasks.

## RESULTS

### The 2010 $M_w$7.2 El Mayor-Cucapah Earthquake Sequence, Baja California, Mexico and Southernmost California, USA: Active Seismotectonics Along the Mexican Pacific Margin

The El Mayor-Cucapah earthquake sequence started with a few foreshocks in March 2010, and a second sequence of 15 foreshocks of M>2 (up to M4.4) that occurred during the 24 hours preceding the mainshock. The foreshocks occurred along a north-south trend near the mainshock epicenter. The $M_w$7.2 mainshock on the 4$^{th}$ of April exhibited complex faulting, possibly starting with a ~M6 normal faulting event, followed ~15 sec later by the main event, which included simultaneous normal and right-lateral strike-slip faulting. The aftershock zone extends for 120 km from the south end of the Elsinore fault zone north of the US-Mexico border almost to the northern tip of the Gulf of California. The waveform-relocated aftershocks form two abutting clusters, each about 50 km long, as well as a 10 km north-south aftershock zone just north of the epicenter of the mainshock. Even though the Baja California data are included, the magnitude of completeness and the hypocentral errors increase gradually with distance south of the international border.

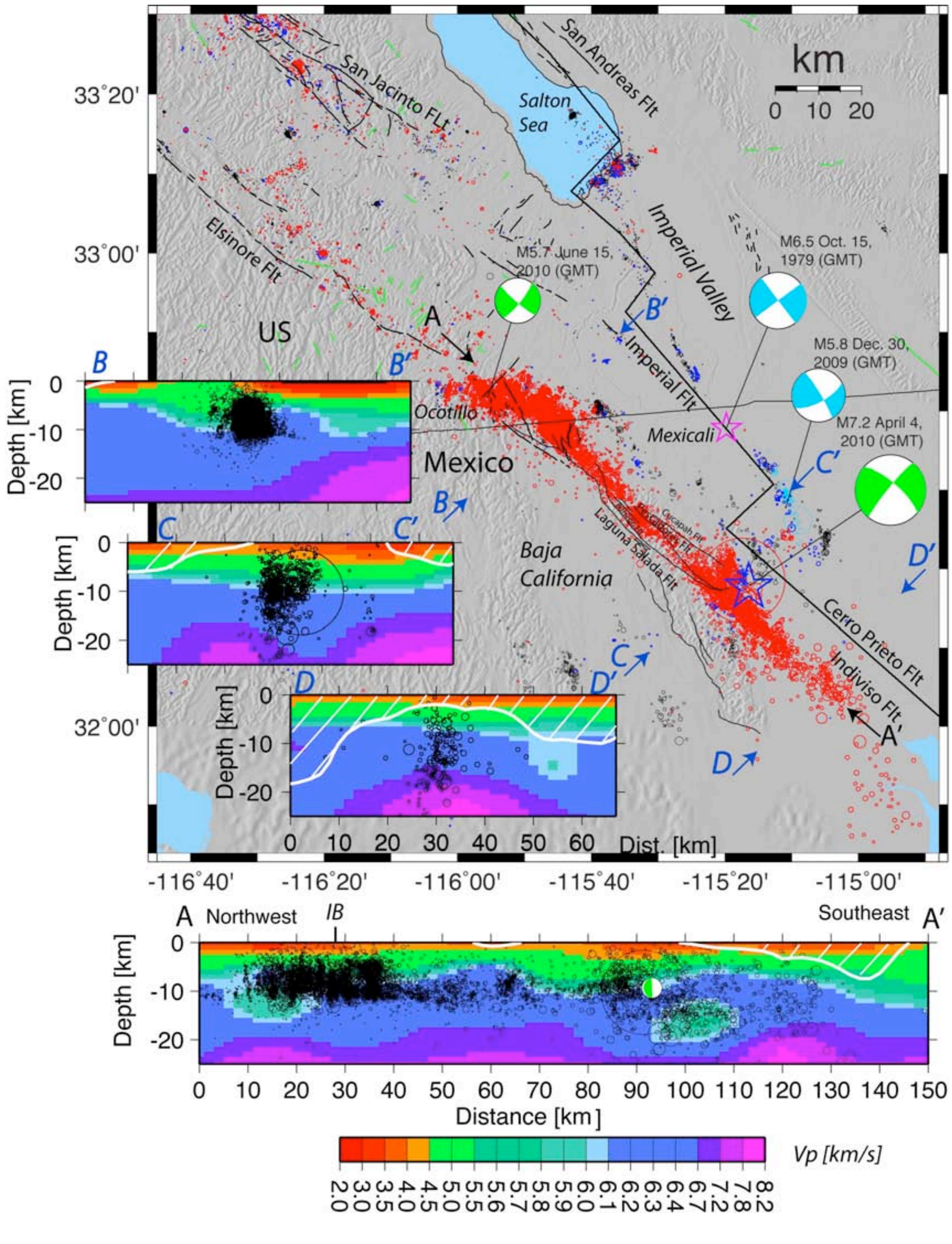


*Figure 1. Map of the relocated hypocenters of foreshocks, mainshock, and aftershocks and 2009 background seismicity. The mainshock epicenter is indicated by a star. Foreshocks are shown as blue open circles beneath the mainshock star. The locations of the Vp cross sections are indicated by the A-A' (includes focal mechanism of mainshock, and IB – US-Mexico international border), B-B', C-C', and D-D' end points. The model areas that are crossed out with white lines are poorly resolved.*

The spatial distribution of large aftershocks is asymmetric with five M5+ aftershocks located to the south of the mainshock, and only one M5.7 aftershock but numerous smaller aftershocks to the north (Figure 1). Further, the northwest aftershock cluster exhibits complex faulting on both northwest and northeast planes. Thus the aftershocks also express a complex pattern of stress release along strike. The overall rate of decay of the aftershocks is similar to the rate of decay of a generic California aftershock sequence. In addition, some triggered seismicity was recorded along the Elsinore and San Jacinto faults to the north but significant northward migration of aftershocks has not occurred. The synthesis of the El Mayor-Cucapah sequence reveals transtensional regional tectonics, including the westward growth of the Mexicali Valley and the transfer of Pacific North America plate motion, which is transferred from the Gulf of California in the south into the southernmost San Andreas fault system to the north. We propose that the location of the 2010 El Mayor as well as the 1992 Landers and 1999 Hector Mine earthquakes may have been controlled by the bends in the plate boundary (Hauksson, *et al*., 2010).

## Analysis of Seismicity, Focal Mechanisms and Stress Drops from Past 30 Years Earthquakes Data in the East Los Angeles Basin Area

We analyze relocated earthquake data recorded over the last thirty years for the characteristics of seismogenic zone inside the East Los Angeles basin area (Figure 2).

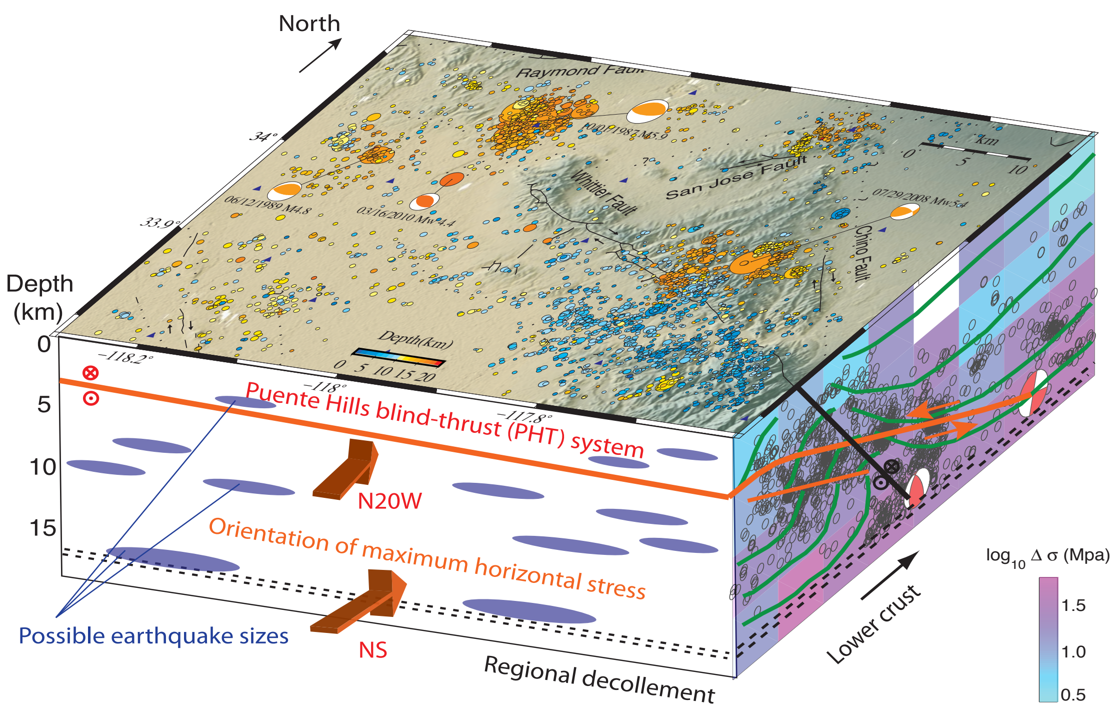


*Figure 2. A comprehensive seismotectonic view of the ELA basin area. The top of the 3D block is the topographic map view of the ELA basin area. On the front face of the 3D block, orange arrowheads mark the maximum horizontal stress orientation at shallow and bottom depth respectively, and blue ellipses mark possible earthquake sizes in different depth ranges. The right-side face is the projection of the Whittier anticline (green curves), the Whittier fault (black line) and the faults of Puente Hills blind-thrust system (orange lines). The PHT system is also marked on the front face. The dashed lines at the bottom of both front and right-side faces mark the regional decollement and the lower crust is underneath.*

The spatial pattern of seismicity generally extends along the strike of the Whittier fault at shallow depth (0 - 6km) with *b* value large than 1.0 and the highest probability density of normal faulting. In the intermediate depth (6 - 12km), seismicity dissipates to the whole area with *b* value equaling 1.0 and mostly strike-slip faulting. In the bottom depth (12 - 18km), seismicity concentrates into few clusters with somewhat SN strike, earthquakes with large magnitude tend to occur, and the *b* value is less than 1.0 with thrust faulting dominating. The stress field orientation inversion shows that the direction of maximum horizontal stress rotates from N20°W at shallow depth to SN direction at the bottom of the seismogenic zone. The *P*- wave source spectra inversion shows that stress drop generally increases with depth from around 7Mpa at shallow depth to around 33Mpa at the bottom of seismogenic zone. All these results suggest stress concentration at the bottom of the seismogenic zone and at least two stress fields coexist inside the East Los Angeles basin area. A possible seismotectonic diagram is proposed to summarize the characteristics of seismogenic zone inside the East Los Angeles basin area (Yang and Hauksson, 2011).

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